METOC SUPPORT WITHIN COMMAND& CONTROL SYSTEMS: CONTEXT-SENSITIVE METOC DECISION SUPPORT TOOLS

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ABSTRACT:

The concept of context-sensitive METOC decision support tools is described using a specific scenario and a notional mission planning system as a vehicle for demonstration. To better understand the challenges of integrating METOC support into the decision-making process, a simple conceptual framework is first presented. This framework is proving beneficial for hammering out integration details. It categorizes integration into situational awareness, constraint-checking, and context-sensitive decision support tools.

As planners build battle plans, their C^2 systems continually check constraints on what they are trying to accomplish. As the knowledgebase detects problems, the application alerts the planners. Once alerted, they work around the problems using decision support tools at their disposal. Prototypes of possible METOC Decision Support Tools are presented within the flow of the planning process to demonstrate how planners would solve environmental problems.

1. INTRODUCTION:

The goal of Meteorological/ Oceanographic (METOC) support is to inform all levels of command how the natural environment, from the depths of the ocean to the surface of the sun, will impact operations; both ours and our adversaries. Our commanders want the opportunity to exploit the natural environment wherever and whenever they can.

Toward that end, much work is being done in the weather community to enhance anticipation skills and to figure out automated ways of determining impact. The command and control (C*) community is also working hard to automate the decision-making process, and is making great strides; speed and volume are increasing at an ever accelerating pace. Because of C* successes, without true, complete integration, weather support will end up being completely squeezed out of the process. Therefore, the difficult chore of integrating these two efforts lies before us.

The question then, is, “How do we infuse METOC support into the decision-making process?” What products does the METOC support community need to make available and where will these products reside? To be of any value, they MUST be available within the flow of the decision-making process. Hence, the logical step would be to look at the process and determine were in that process METOC support could add value. It is from this analysis that product, modeling, and data requirements should be determined.

This paper presents a METOC integration conceptual framework that has been proving beneficial for getting a handle around the integration details. A mission scenario suggested by USAF Checkmate, the famed Pentagon think-tank, is introduced and a prototype mission planning system is used to demonstrate how METOC support could be part of the decision-making process. This paper does not present an ultimate solution, but suggests a framework for discussion and future development directions.

2. A METOC Integration Conceptual Framework

Incorporating METOC support into C’ systems has proved to be an overwhelming task. To more easily manage the task, METOC integration requirements can be divided into the following three categories: situational awareness, constraint-checking, and context-sensitive decision support tools. All three are necessary for effective support, but each can be worked on separately.

The most active category, and hence closest to realization, is situational awareness. As it stands currently, the main way commanders and planners are kept apprised of the weather is via stand-up briefings. On a cyclic basis, weather duty officers use weather applications to create slides and then present these slides to explain how the anticipated weather may impact strategies and plans.

Very soon, command centers will have battlefield situational displays that show the situation in real-time, on a continuous basis. It will display terrain, location of friendly and enemy assets, threats, and the weather up on big screens visible to all. Duty officers will be able to look up at a screen to evaluate the current situation as they need it.

Most C* systems under development have requirements to overlay weather information directly on their map displays. However, there has not been much progress making this happen. The main obstacle has been the incompatibility of weather products with the Common Mapping Program standards. The next generation mapping standard, the Joint Mapping Toolkit, has substantial requirements to provide functions that will enable C* systems to overlay weather information. Duty officers will eventually be able to toggle overlays of “weather” on their situational maps.

Situational awareness is a necessity, but depending only on map representations has a limitation. Decision-makers at the force level are making hundreds to thousands of decisions in short succession. There is j ust too much going on, too quickly for a human brain to maintain the connection between what is being planned, the hundreds of applicable weather-thresholds, and the anticipated weather. Even if a person could keep up, continually comparing map overlays with intentions is simply too time consuming. Hence, the application will have to maintain the links for them.

As planners define events, the application, in the background, would compare the weather at the time and location of the event with thresholds specific to the event. Thresholds must be a function of things like mission, tactics, aircraft, and weapon system. If the weather is beyond a specific threshold, the application generates an alert and displays it on the planner’s screen. As with any other threshold violation like running out of fuel or tasking a sortie to fly faster than capabilities, the duty officer will click on the alert flag to see what the problem is. When the flag is clicked, a dialogue box will pop up to display the reason or reasons for the alert. They will have the opportunity to either ignore the alert or solve the problem. It is at this point that duty officers need tools available to help get around the problem.

One problem that C^2 system developers must contend with is information overload. It is imperative that users get only the information necessary to solve the specific problem. Hence, it is important that the tools available be sensitive to the context in which they are called upon. All of the information presented must be tailored to the problem at hand. This is the place for true, real-time, on-the-fly METOC support tailoring.

Another important concept to keep in mind is that METOC support is only one of the parameters mission planners have to contend with. Hence, it is necessary to think of METOC support as only part of the decision support toolkit. Consequently, it is better to talk about context-sensitive decision support tools with integrated METOC information.

3. DEMONSTRATION

The best way to describe this concept of context-sensitive decision support tools with integrated METOC information is to propose a scenario, plan a mission to meet the objective, and describe the tools as they pop up. The scenario presented was inspired by a briefing Col Bob Plebanek gave while he was at HQ USAF Checkmate Division (Plebanek, 1996). His strategy-to-task guidelines provided the framework for creating a realistic objective with constraints that would require four of the five components (Air Force, Army, Navy, and Special Forces) and a Combined Force asset (United Kingdom) to work together.

The objective is to supply 10 tanks, 6 helicopters, and a water storage capability to a site prepared by a Special Operation Forces (SOF) unit at a coastal location near the Forward Edge of Battle Area (FEBA). As part of the mission planning challenge, the force-level planners must locate the SOF site, the supplies, and a means to transport them. A constraint levied on the plan is that the supplies must be collected at a naval port and delivered to the SOF unit via cargo ship. A C-130 must bring the water storage system and tanks must transport themselves to the port. The cargo ship will have to be protected from an en route threat with an available U.K. destroyer and attack submarine. Finally, one of the six Apache helicopters must eliminate a shore threat along the way.

Rome Laboratory has been developing a mission planning mockup to describe complicated concepts without having to be bogged down with complicated systems. As with all C^2 systems currently being developed, this mockup is graphics based with pull-down menus, pop-up lists, and hot-buttons to accomplish tasks. The mockup demonstrates how a planner at the force level (Joint Task Force Level) would go about tasking assets to meet objectives and ultimately strategies.

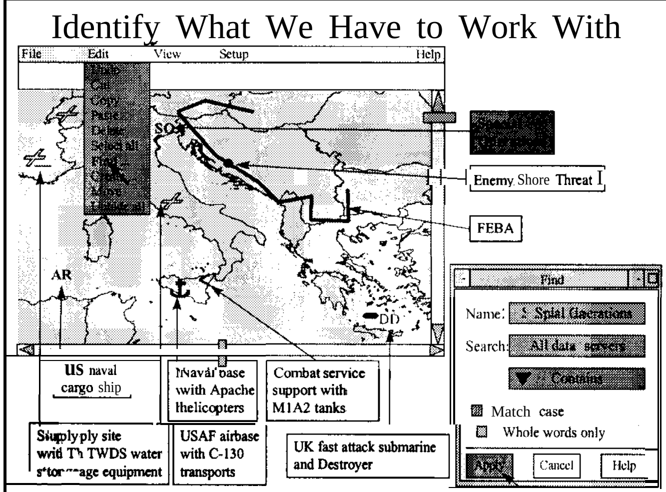

Figure 1: Mission Planning System

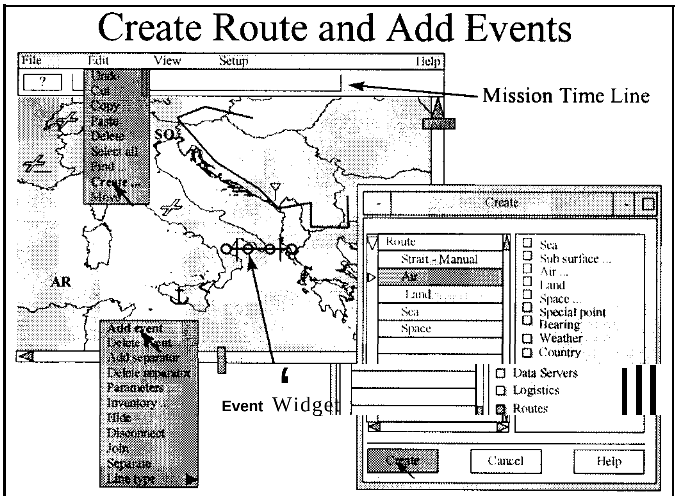

Figure 2: Drag, Drop, and Fill in

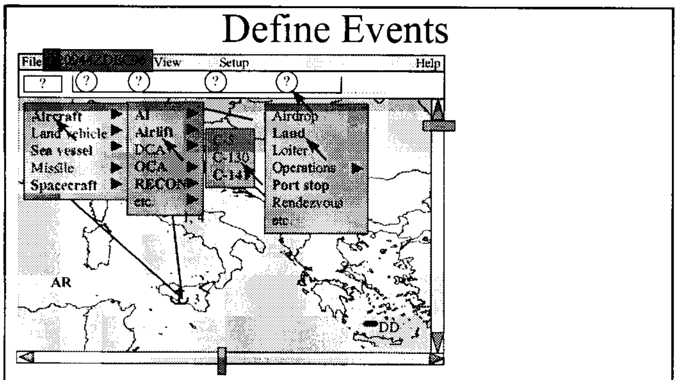

Figure 3: Airlift TWDS

The first step toward building a plan that would meet the defined objective is to search for resources. Clicking on ***Edit*** then ***Find*** would bring up tools to search pertinent data servers for the items needed. The results of the searches would be displayed on the map as the items are found (Figure 1).

Clicking on ***Create*** then ***Add Event*** would bring up two features: an Event Widget used to graphically anchor event hooks (circles) to map features, and a mission time line used to define the events (Figure 2). A planner would click on the event widget and drag the circles on to the appropriate glyph on the map. For this particular scenario, dragging the widget on to the airlift base glyph would anchor the first circle there. The next step would be to drag the widget to the airfield with the TWDS. The second circle would latch onto that airfield glyph. Continuing, the widget would be anchored to the naval port and then back to the original airfield to complete the circuit.

Clicking on the event place-keepers in the mission timeline would display pop-up menus. Choices offered in these menus would only be those that are available to the planner at the time. For example, in Figure 3, C-5s, C-130s, and C-141s are stationed at the launch airfield but only “C- 130” is highlighted as a possible choice. This is because all of the C-141s are tasked and the application knowledgebase determined that C-5S can not land at one of the airfields that was anchored.

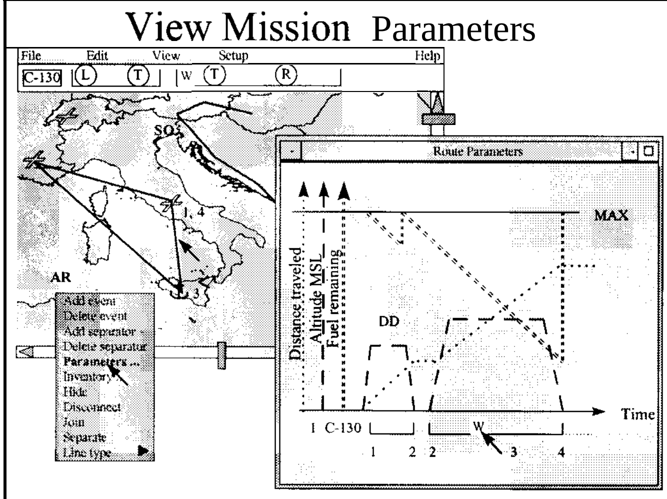

Figure4: Click Alert Flag

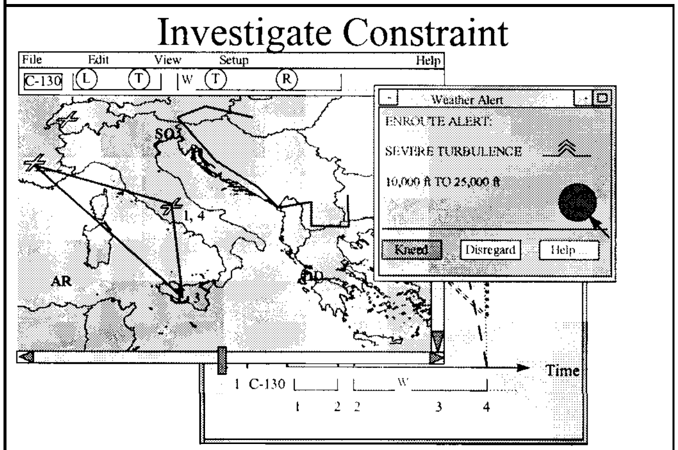

Figure 5: Toggle Weather Overlay

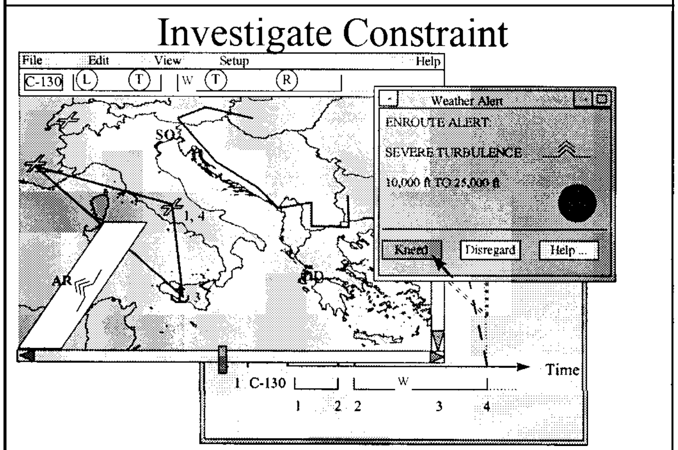

Figure 6: Pull Up Help

Once a mission is defined, clicking on ***Parameters . . .*** would bring up a timeline chart showing how important mission-parameters are resolving (Figure 4). Note that as this mission was defined, an alert flag appeared on the mission timeline (and subsequent parameter timeline). In this case, a "W' signifies that weather at the time and location of a critical event is beyond a threshold of that event (as specified in the system's knowledgebase). The application is constantly checking the constraints on what is being accomplished.

Also note, however, that the system doesn't directly intervene and keep the planner from continuing on without the problem being resolved. This feature is a result of user requirements and feedback. Applications must allow planners to ignore warnings and constraint violations. This reasoning is also why the alert is registered as a flag and does not go immediately to an intrusive dialogue box.

In this demonstration, the planner chooses not to ignore the weather problem and clicks on the alert flag. Only then does a dialogue box pop up to explain that there is severe turbulence somewhere en route (Figure 5). Clicking on the map toggle would overlay the area of offending weather on the map (Figure 6). Realize that the turbulence fore- " cast displayed is specifically for a C-1 30 airframe.

One can argue that having the weather on the map at the beginning of this process would provide situational awareness and save this step. However there are two barriers to doing it that way. First, users insist that displayed information be kept to a minimum to mitigate clutter. The second, and more poignant, barrier is that until the planner defines the event, weather impact is indeterminable. This is a key consideration when discussing tailoring METOC support for the warfighter; especially outside of the decision-making process. Until the event is defined, there is no way to specify impact.

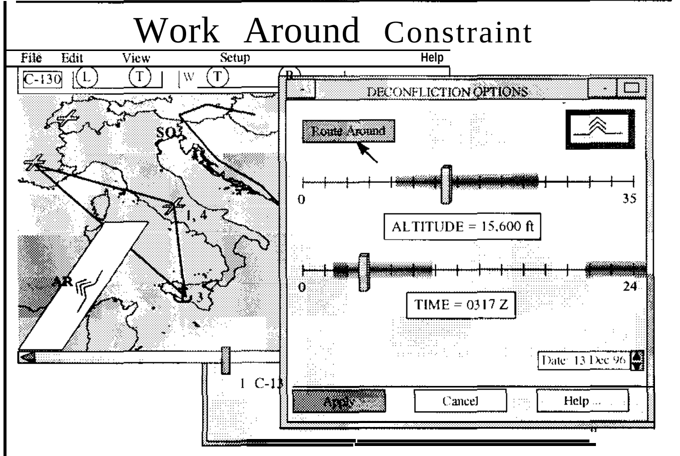

Figure 7: 1-D Tool Example

But once a planner defines a mission and the computer sounds the alert, how do they get around the problem? Clicking on *Kneed* would pull up a tool that would help make a decision to do just that. One important aspect that must be dealt with is that weather is four dimensional (with time the fourth dimension). A map shows two dimensions, but some of the simpler decisions could use a 1-D tool like that shown in Figure 7. The constraints would be highlighted on the scroll line (darker shading) and a planner would move the scroll bars until the flight path is outside of the hazardous space. As shown here, the planner could change altitude, time, or route to solve the problem. Clicking ***Apply*** would enter the changes into the system and display the results on the map and mission timeline.

Since we have a 2-D screen, perhaps we should strive for 2-D tools as much as possible An altitude by time chart, as shown in Figure 8, would allow the planner to solve the problem with one click and drag of the cross-hair. A time scroll on either the tool window or the map window would allow the planner to manually animate the hazards to see when the hazard would be out of the way. The two windows would be dynamically linked so that a change made in one would be reflected in the other. For example, moving the cross-hair in the vertical cross-section along the time axis would alter the shape of the area represented on the map.

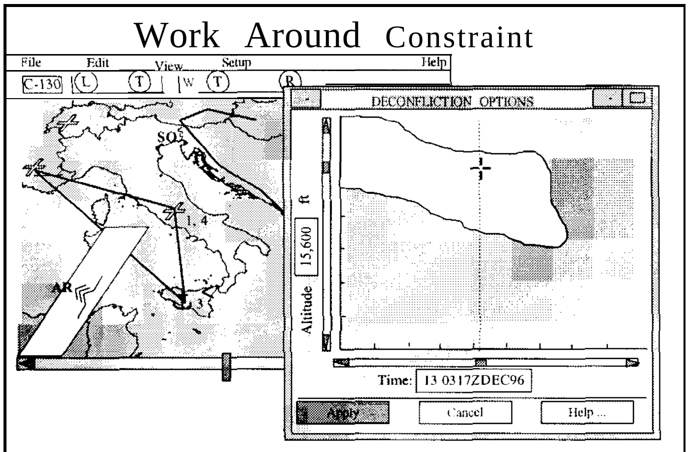

Figure 8: 2-D Tool Example

Perhaps a more expedient, more practical tool would be a 3-D representation of the hazards and a time scroll. NOAA, Environmental Research Laboratories, Forecast Systerns Laboratory, Aviation Division, Aviation Gridded Forecast System Branch is working on 3-D visualizations of aviation hazards. They are using AVS®, from Advanced Visual Systems Inc., as a user-interface for their Aviation Impact Variable (AIV) Editor (AIV, 1996). AIV views hazards in 1,2 and 3 dimensions.

Work Around Constraints

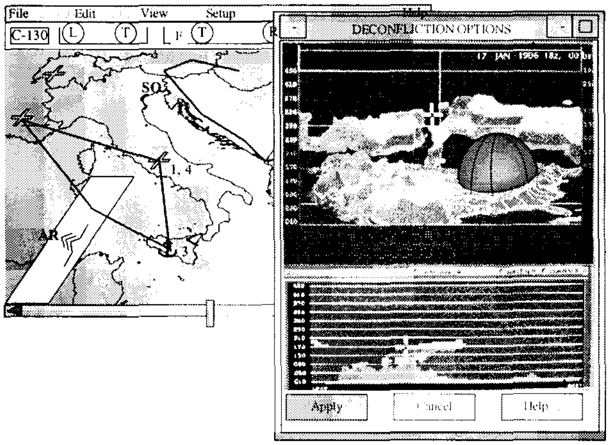

Figure 9: 3-D Total Integration

What must be done to make this product useful to the decision-maker is to incorporate it within the C[2] system (Figure 9). As described previously, all threats must be included in the view; the weather "threats" would be just part of the overall threat environment. As depicted in Figure 9, the planner would see weather hazards along side enemy air defense hazards (bubble). In this window, the planner would click and drag the cross-hair to an open area. If necessary, the planner would manipulate orientation toggles to get the best view (Pitch, Yaw, Zoom, and Time). Clicking on ***Apply*** would change the event widget and mission timeline accordingly.

Note that when the route got longer, a fuel alert appeared. Clicking on this flag would pop up an options list or a decision support tool that would help plan around this problem. Some of the obvious choices are to add extra fuel at the first or second airfield or via an air re-fueling. A not-so-obvious choice would be to find an altitude (and/or time) with more favorable winds. Critical wind factors represented in Figure 9 would then be necessary. Having the application constraint-check altitudes for the most favorable winds on a consistent basis and then prompt for change (or automatically adjust) would be a tremendous force multiplier! Over the course of an operation, fuel savings, both financially and logistically, would be significant. Potentially, one small operation could pay for the total weather integration effort.

Anchor Apache Hooks and Define Events

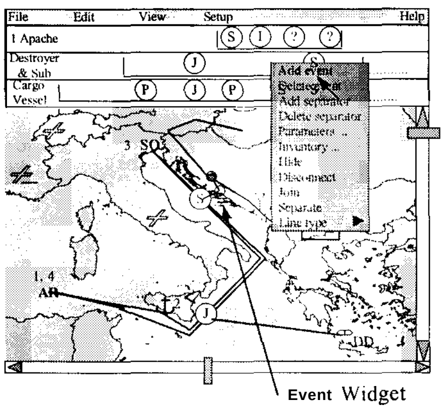

Figure 10: Drag, Drop, and Fill In

Fast forward through the planning process to the next to last scenario task: destroying the shore threat. As with the airlift process, a planner would click on *Create* then *Add Event* to bring up an Event Widget and a Mission Timeline, and then

Define Strike Target

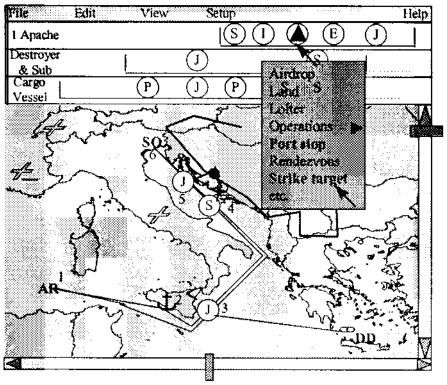

Figure 11: Select Target Circle

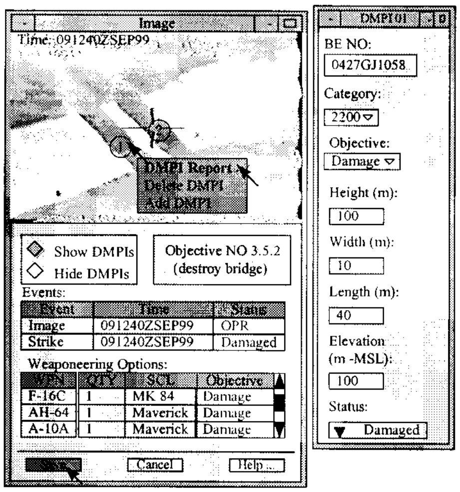

Figure 12: Select DMPI and Weapon

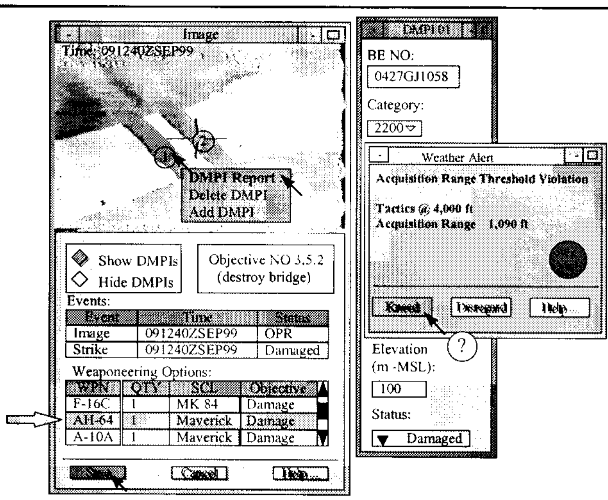

Figure 13: Work Around Problem

drag, drop, and fill to build an Apache mission (Figure 10).

The planner must also build the details of the strike against the target. Simply by clicking on the event circle and selecting ***Strike Target*** from the pop-up menu (Figure 11), the planner can pull up a target/ weaponeering tool (Figure 12).

The tool represented in Figure 12 integrates target intelligence into the decision-making process. Notice that the planner has target imagery, target details, and weaponeering information only a click away. The tool would allow planners to query the target database to garner the information they need to optimize the plan. Ultimately, they are looking for optimum attack directions, time over target, air deconfliction with other missions, weapon choice, and threat mitigation or elimination requirements.

When a planner enters enough detail (e.g., times, locations, weapon type, etc.) for the application to determine constraints, alert-flags and highlighted-options would appear. Eventually the planner will run into problems that require resolution. This, again, is where context-sensitive decision support tools come into play.

As depicted in Figure 13, selecting target points, weapon, and time over target triggers a threshold violation. When a planner clicks on *Kneed,* a window with an appropriate decision support tool would pop up. What will it look like?

4. The Future

Answering questions like this one will help the weather community determine productive research paths to follow and help the C* community integrate METOC support in places and ways that enhance the decision-making process. These answers will also, collectively, answer the bigger question, "How do we infuse METOC support into the decision-making process?" The overall strategy is to break the effort into three categories of integration: situational awareness, constraint-checking, and context-sensitive decision support tools.

First, warfighters need to be aware of the situation. Situational awareness displays are an important feature of all command centers. Once the planning process starts, planners need help making sure that what they are building is doable. Hence, computer constraint-checking, in the background, on a non-interference basis, alerting by exception, is a necessity. Indeed, constraint-checking is an integral part of modern C* strategies. However, what the warfighter does once the application sounds an alert that a threshold has been violated has not been adequately addressed.

The obvious step is to provide the warfighter with interactive windows displaying all of the necessary information tailored to the problem at hand; all integrated within the planning process. In other words, they need context-sensitive decision support tools. To be of any use, these tools must contain information fused from ALL functions (e.g., intelligence, weather, logistics, tactics, and command guidance).

The USAF C* development program, Theater Battle Management Core Systems (TBMCS) and specifically the Force Level Execution System (FLEX), are looking to incorporate these ideas. The requirements have been established. However, priorities for the System Program Office are such that there are currently minimal, if any, resources available to tackle METOC support integration problems.

It would be extremely helpful if Rome Laboratory could provide the contractors with a collection of functions, models, datasets, etc. that they could quickly incorporate into their systems. The Acquisition Meteorology Office envisions a METOC Toolkit not unlike the Joint Mapping Toolkit currently under development. Like Rome Laboratory's Common Mapping Program, the Joint Mapping Toolkit will be a library of compatible functions that a programmer can simply match parameters and drop into the code. The Electro-Optical Systems Atmospheric Effects Library (EOSAEL), the Master Environmental Library (MEL), and other cataloging efforts currently underway will help considerably, but none of them yet provide the plug-and-play capability that contractors require and a toolkit would provide.

As of the publishing of this paper, contractors are not being given the resources to figure out METOC support integration on their own. If METOC support is to remain a viable contributor to the ever accelerating decision-making process, we must, as a community, either find the funds to beef up contractor resources, or develop the answers ourselves and provide them with standardized plug-and-play functions.

Acknowledgments. I am indebted to lLt Gregory M. Smith, USAF Rome Laboratory, Command & Control Directorate, Advanced Concepts Branch (RL/C3AA) for letting me help him develop his notional mission-planning system and allowing me to use it for this paper. I also wish to thank Captain Robert J. Carroll, Jr. (ACC/DOWR) for his insightful advice and review of this paper.

5. REFERENCES

AIV: Aviation Impact Variable Editor User's Guide, NOAA, Environmental Research Laboratories, Forecast Systems Laboratory, Aviation Division, Boulder CO, and National Weather Service, National Centers for Environmental Prediction, Aviation Weather Center, Kansas City, MO, Version 3.0, February 14, 1996.

Christensen, Charlotte W., and Jonathan D. Turton: "Co-Operation On Meteorological Tactical Decision Aids Within NATO," In ***Proceedings*** *Battlespace* ***Atmospheric*** *Conference 96*, NRaD, San Diego, CA 92152, (in press), 1997.

EOSAEL: Electro-Optical Systems Atmospheric Effects Library, www.eosael.com, as of 10 January 1997.

MEL: Master Environmental Library, www-mel.nrlmry. navy. rnil, as of 10 January 1997.

Piwowar, Thomas M., John Burgeson, Paul Try, Donald Grantham, Sam Brand, and Alan Wetmore: ***Natural Environmental Effects In Military Models and Simulations: Part I - A Survey of Requirements, PL-TR-96-2029,*** Phillips Laboratory, Directorate of Geophysics, AFMC, Hanscom AFB MA, 01731-3010,259 pp., 1996.

Plebanek, Robert, Col USAF: "JFACC Planning Process to Support Integrated Airpower Employment", ***Defensive Planning Module Technical Interchange Meeting,*** Alphatech Inc., Burlington, MA, 29 May 1996.